

Alternatives to the Use of Natural Gas

Environmental Issues Associated with Gasification Technology

Alberta's Environment Conference 2006

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***Eddy Isaacs, Executive Director
Alberta Energy Research Institute***

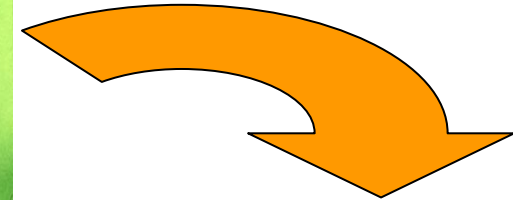
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“Technology Oil “

Continuous Innovation Since the 1930's



Lots of hydrogen



Energy Requirements

➤ Surface mining

- ❑ Fuel - Diesel
- ❑ Process Heat
- ❑ Electricity - Co-gen.

➤ In situ

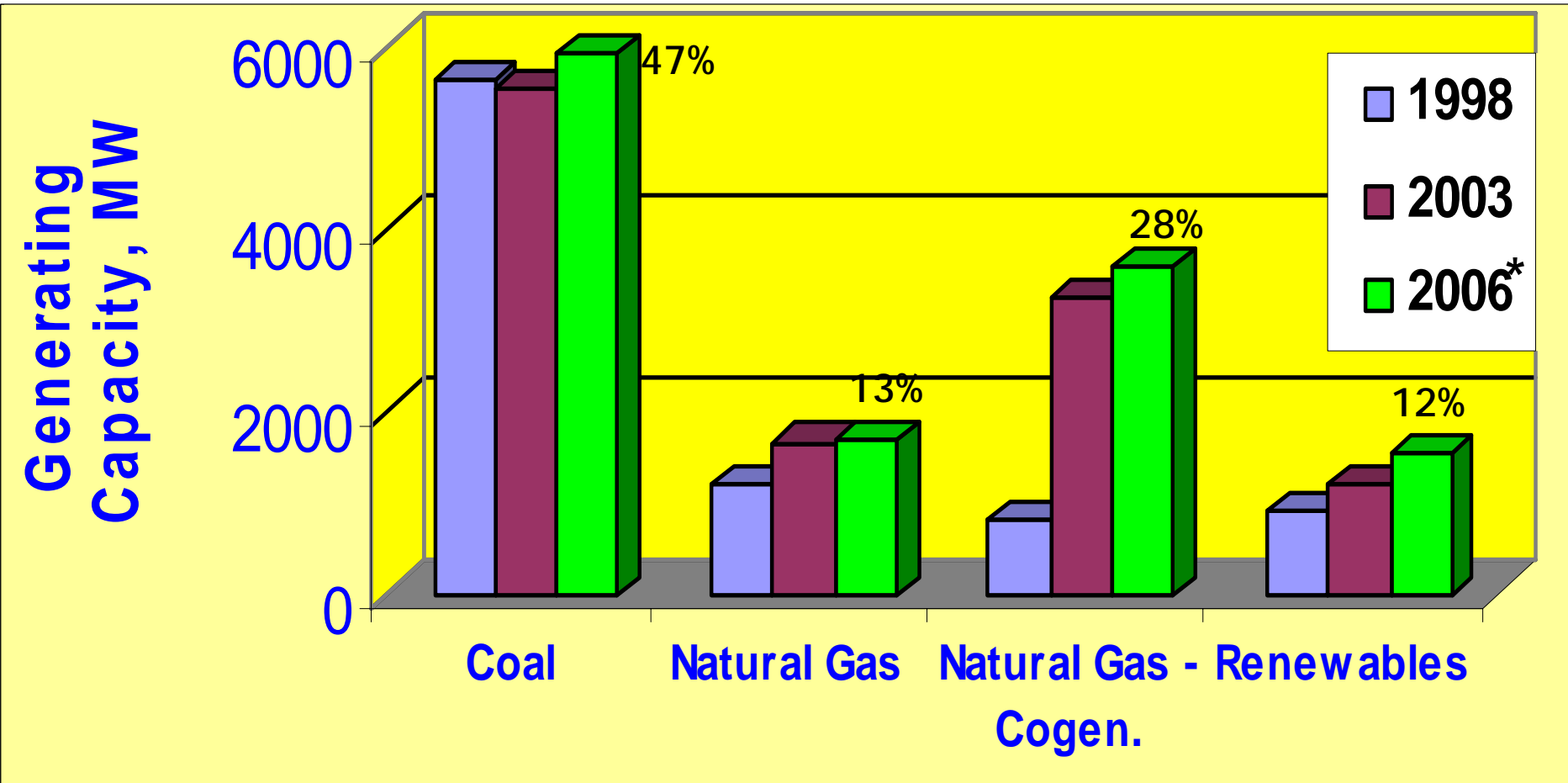
- ❑ Steam

Natural gas

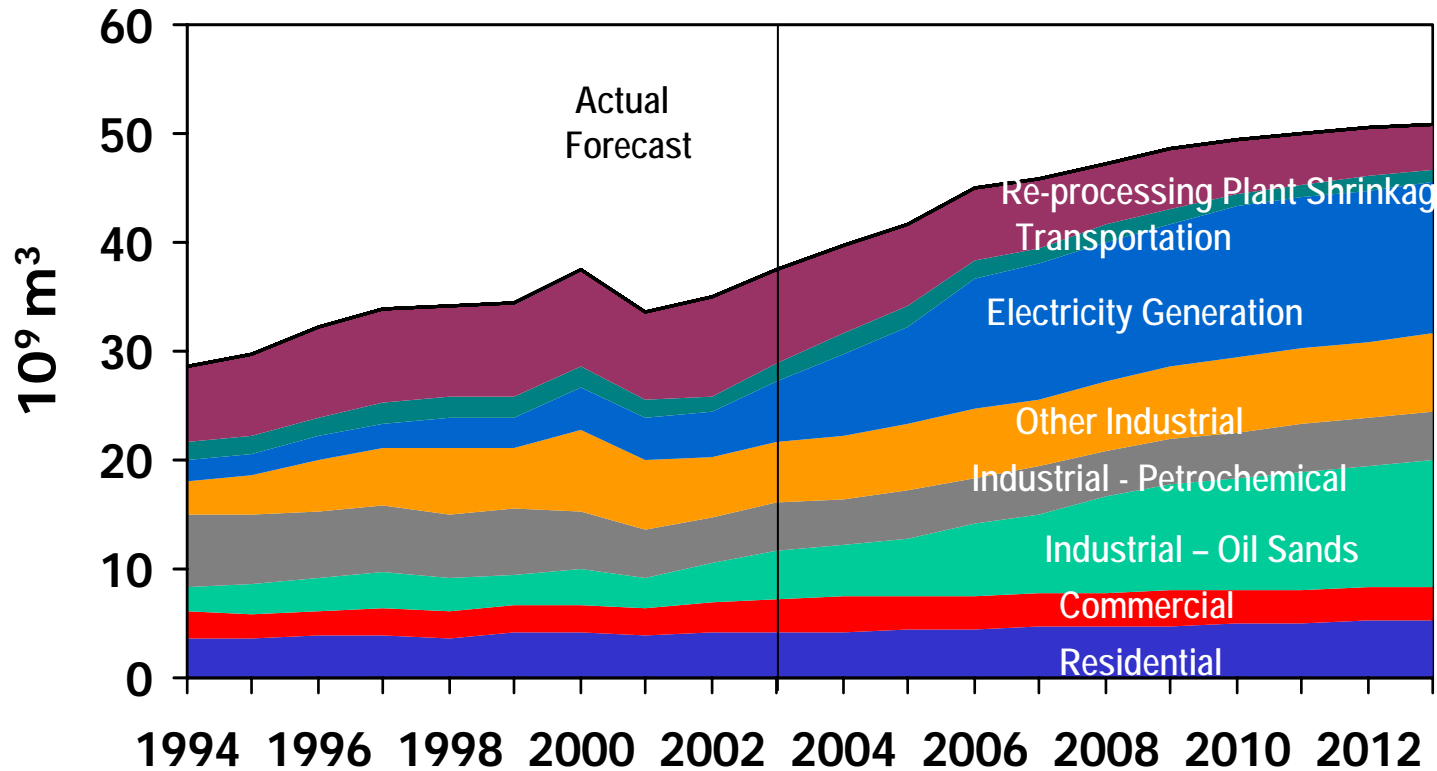
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Alberta - Electricity Generation Sources



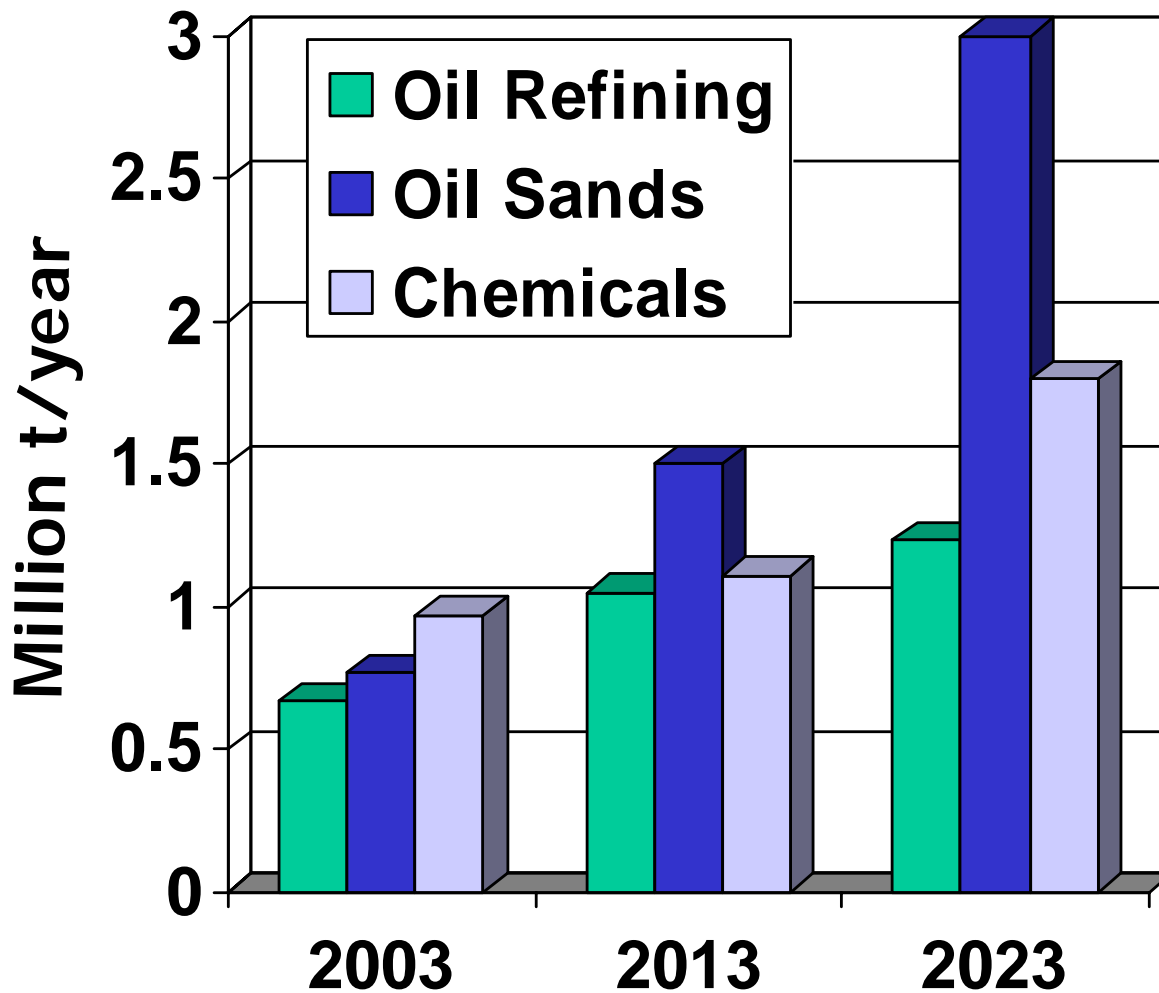
Alberta Gas Demand by Sector



➤ Disposition of Alberta's Natural Gas - 2003

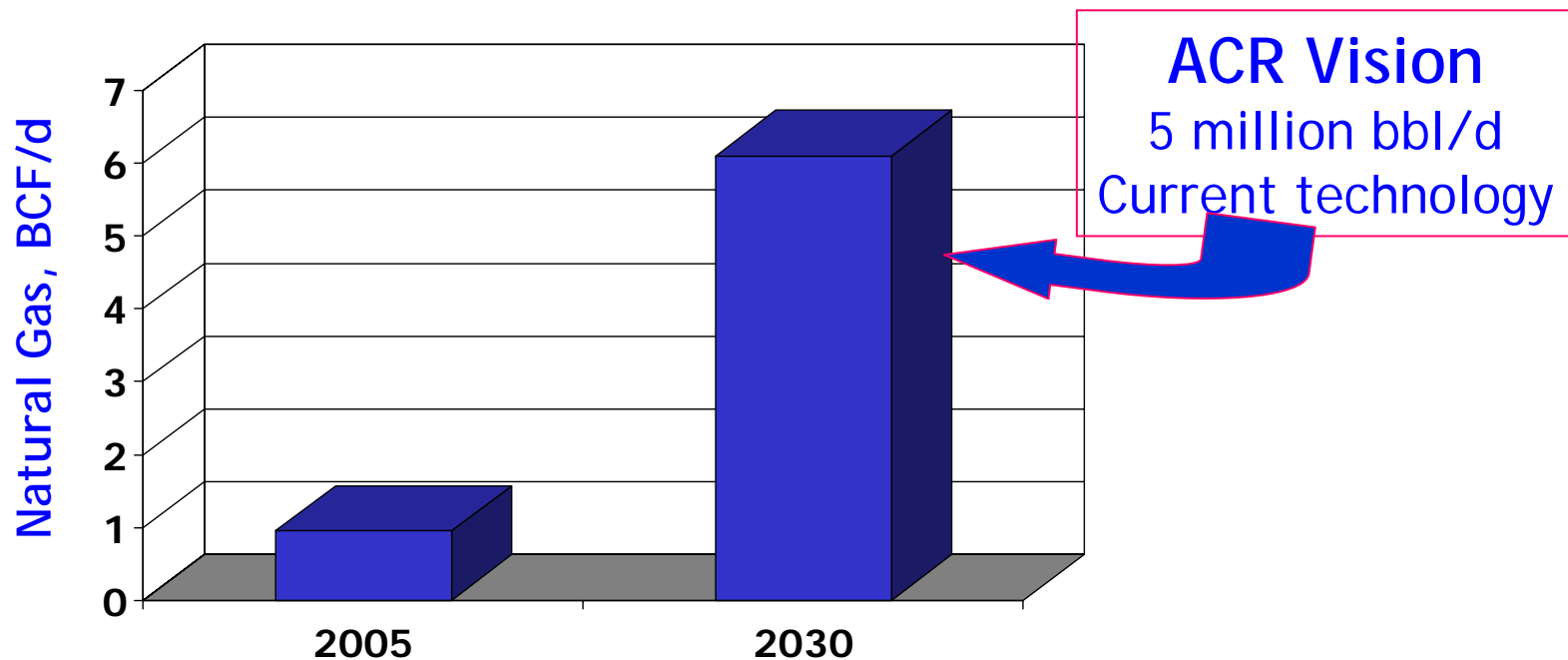
- ❑ U.S. - 62%
- ❑ Canada (other than Alberta) - 24%
- ❑ Alberta - 14%

Canadian Hydrogen Demand Growth



Source: Canadian Hydrogen: Current Status and Future Prospects, Study for Natural Resources Canada, August, 2004

Natural Gas Use for Oil Sands Development



Process	Natural Gas (BCF/d per Million Bbls)
Mining + Upgrading	0.85
SAGD	1.1
SAGD + Upgrading	1.7

Options for Natural Gas Switching Innovation to reduce and replace

- Enhancements to SAGD
 - ❑ Steam-solvent hybrids
 - ❑ ES-SAGD
- Solvent Processes
 - ❑ Vapour extraction (VAPEX)
 - ❑ Heated solvent
- Combustion
 - ❑ Toe-to-heel Injection (THAI)
 - ❑ Combustion Override Split-Production Horizontal Well (COSH)
 - ❑ Top-down combustion

Options for Natural Gas Switching - Technological Innovation

1. Use bitumen as fuel - examples
 - ❑ Orimulsion - commercial power plant fuel produced by Bitor (Petroleos de Venezuela - PDVSA affiliate)
 - ❑ Quadrise Technology (MSAR) - emulsified water/oil mixture
2. Gasification → hydrogen, steam and power
3. Nuclear → steam, hydrogen and power
4. “Game Changer” - Geothermal → steam

Replacing Natural Gas – Gasification

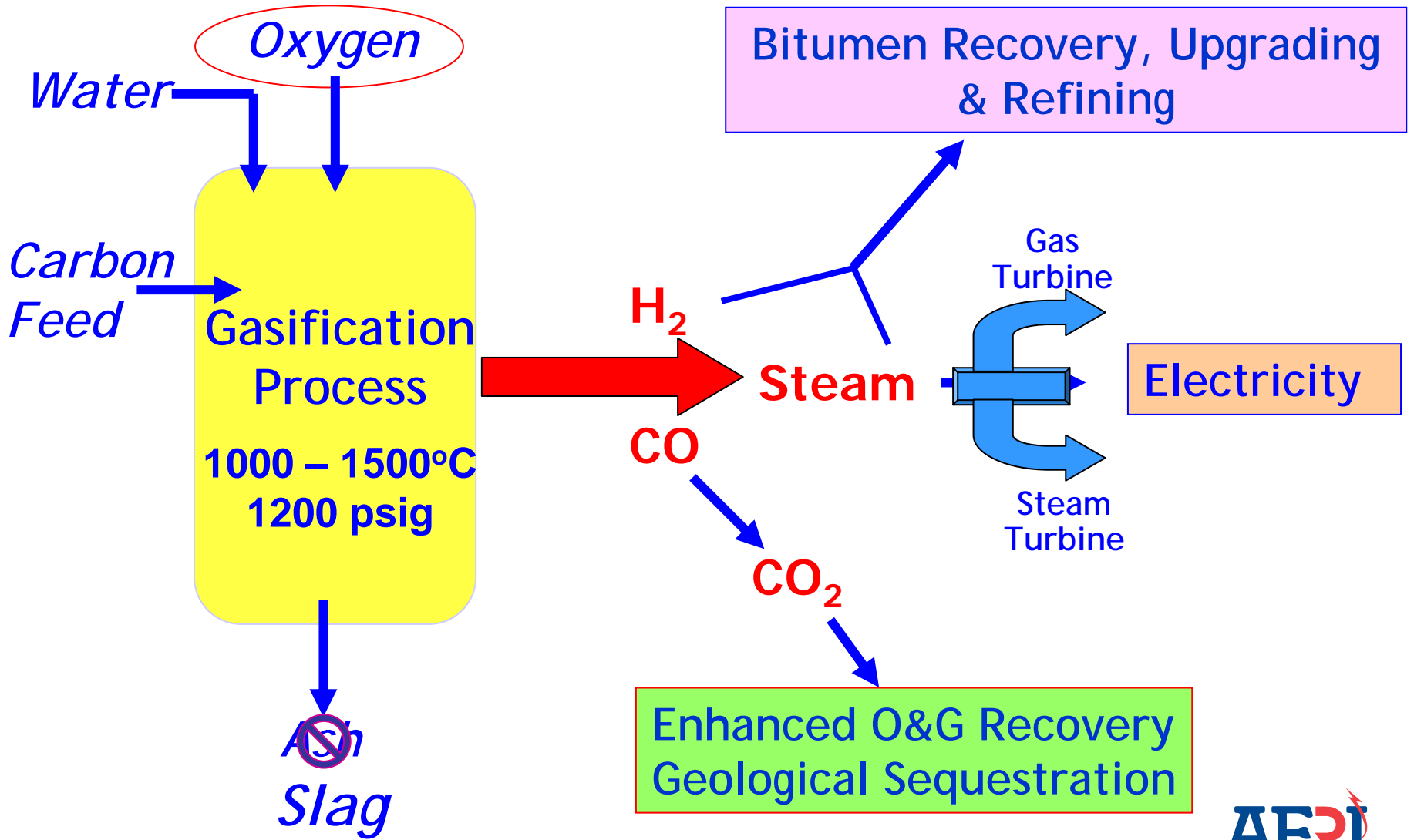
➤ Advantages

- ❑ Commercially ready
- ❑ source of heat, power and hydrogen in mined oil sands and in situ oil sands plants
- ❑ Potential source of CO₂ for enhanced recovery of conventional oil and gas
- ❑ future source of petrochemicals and ultra-clean fuels

➤ Disadvantages

- ❑ Higher initial capital costs
- ❑ Reliability compared to SMR
- ❑ Cost of CO₂ capture ready technology
- ❑ Not always easy to find places for the CO₂

Gasification Process Schematic

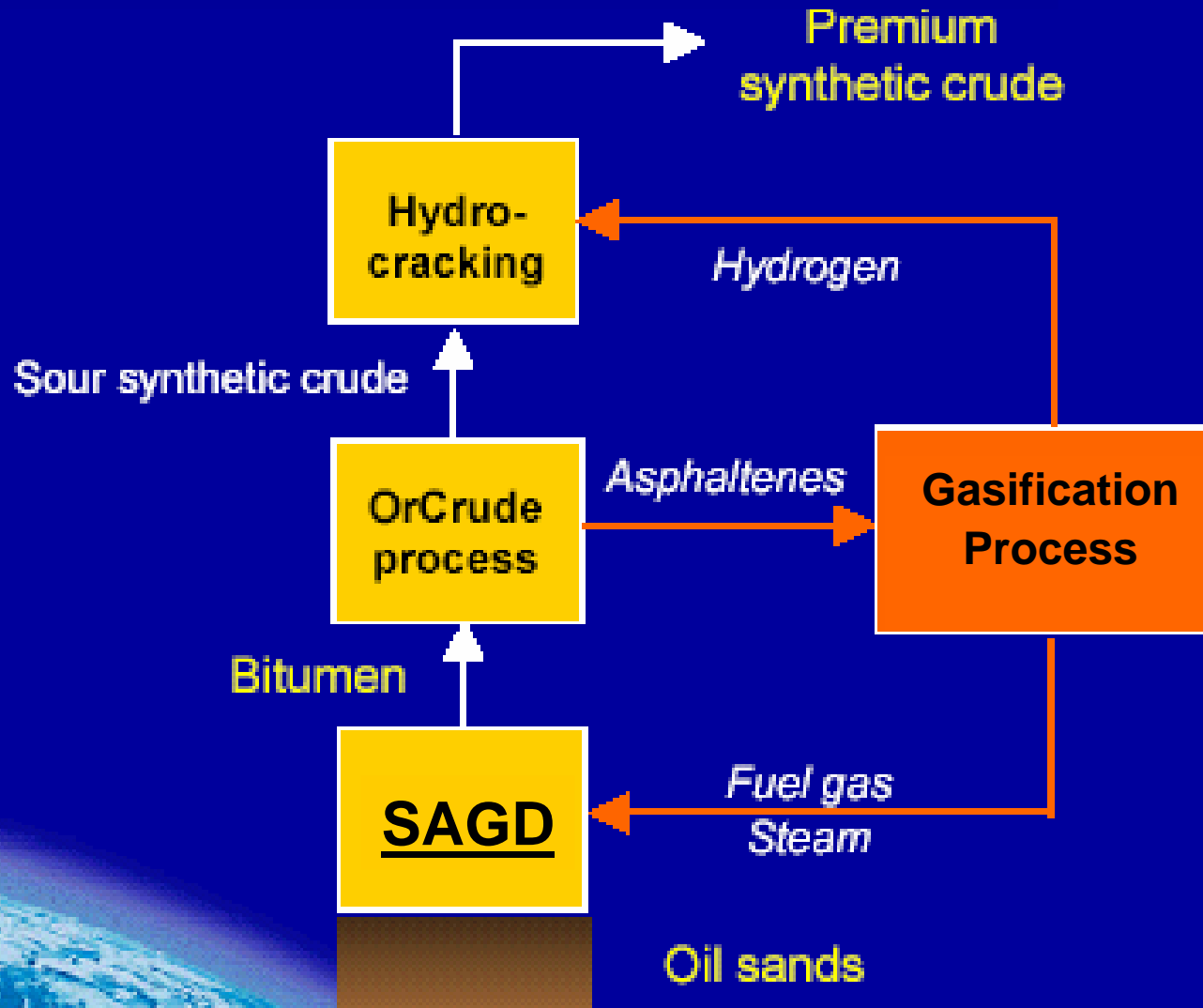


Gasification Feedstock

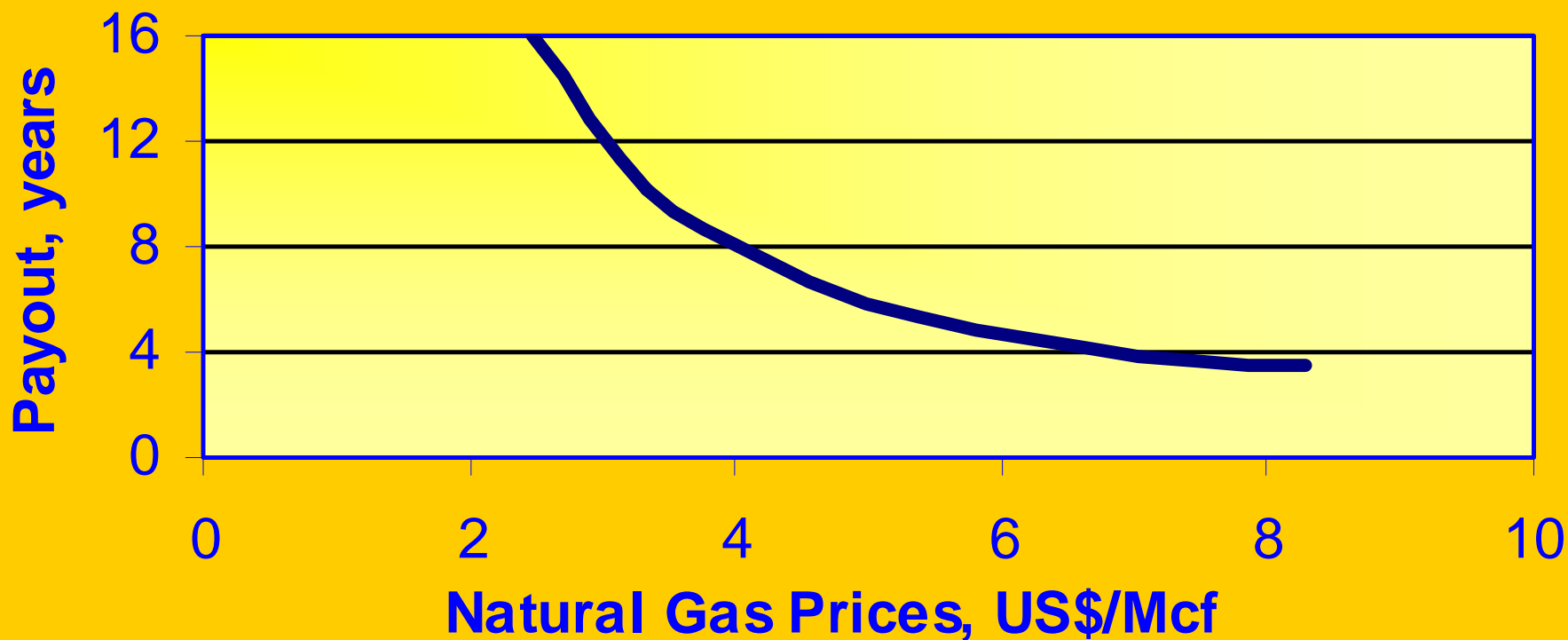
Feedstock	Type
Coals	Bituminous
	Sub-bituminous Coal
	Lignite
	Beneficiated coals
Oil Sands Residues	Delayed coke
	Fluid Coke
	Petroleum Coke
	Asphaltenes
Biomass	Forestry waste
	Agriculture waste
Blended Feeds	Above Combinations

Canada's First Commercial Gasification Plant

OPTI – Nexen Long Lake Project



Gasification Capital Cost Payout – SAGD with an upgrader project

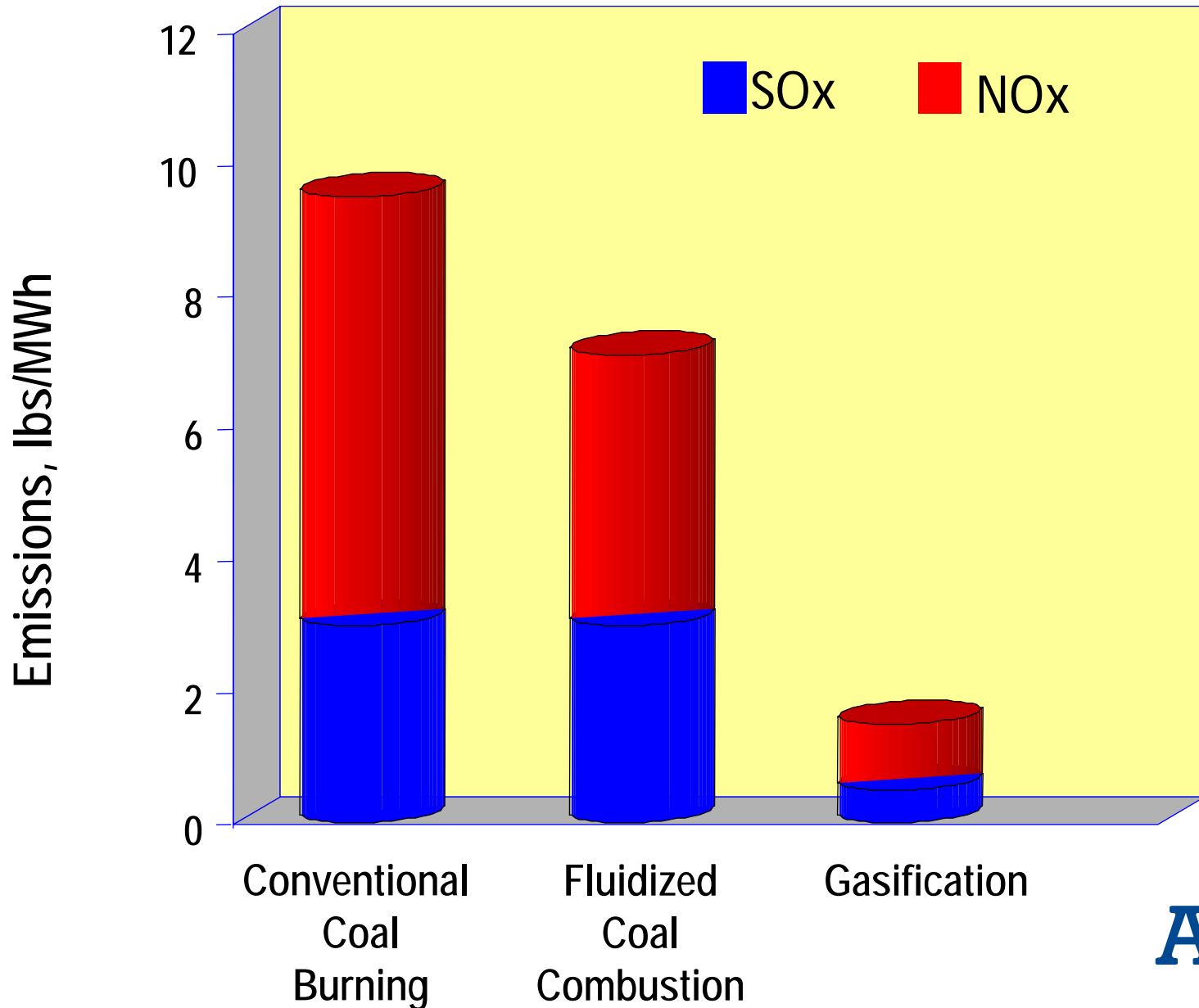


Adjusted for 17% volume shrinkage

Source: FirstEnergy Capital

Environmental Performance of Gasification

(based on Texaco (now GE) Gasifier)



Environmental Performance Supercritical PC vs IGCC (Eastern Coals)

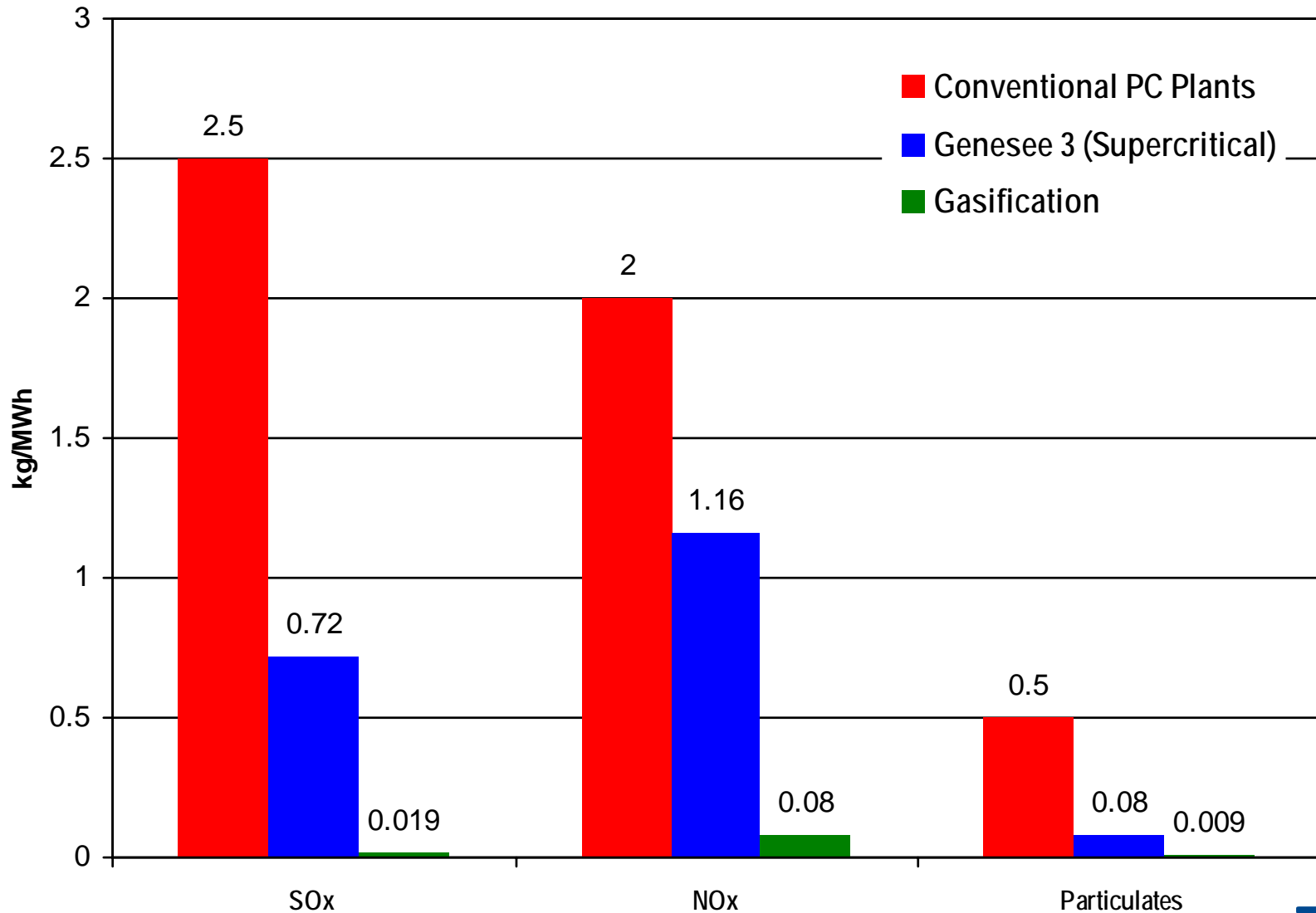
	Kg/MWh	
	S-PC	IGCC
SOx	0.53	0.21
NOx	0.33	0.22
PM	0.07	0.03
VOC	0.02	0.004

	S-PC	IGCC
Mercury Removal	30 – 50%	>90%

	S-PC	IGCC
CO₂ Capture*	>3 c/kWh	1.5-2 C/kWh

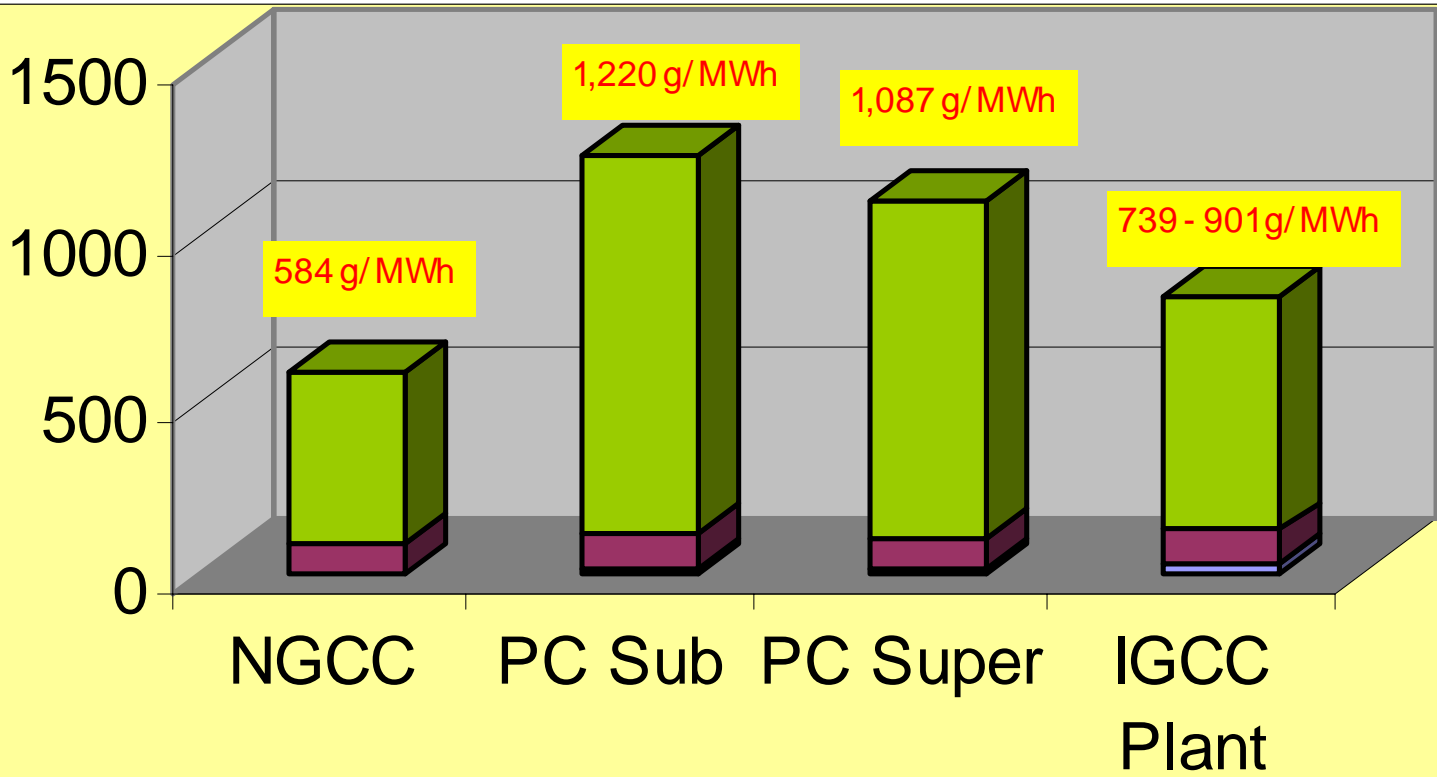
* Incremental cost of electricity

IGCC Dramatic Improvements in Emissions (Alberta coals)



Courtesy: David Lewin, EPCOR

Comparison of Water Loss (based on Pittsburgh #8 coal - 6% moisture)



■ Process Losses ■ Flue Gas Losses ■ Cooling Tower Losses

Source: USDOE Report "Power Plant Water Usage & Loss Study" (Aug. 2005)

Typical Water Requirements for IGCC, m³/hour (Canadian Clean Power Coalition Study)

Process Unit	Slurry Fed Gasifier Bituminous Coal 440 MW Net	Slurry Fed Gasifier Sub Bituminous 440 MW Net	Dry Feed Gasifier Lignite coal 360 MW Net
Process Water/Steam	75	110	0
Cooling Water - Gas	15,400	18,500	23,900
Cooling Water - Power Block	27,500 (sea water cooling)	39,400 (cooling towers)	20,400 (cooling towers)
TOTAL	43,000	58,000	44,300

Summary

- Alberta (oil sands) will become one of the world's largest:
 - ❑ Thermal heat generating regions
 - ❑ Hydrogen consumers
 - ❑ CO₂ Emitters (w/o mitigation)
- New combination of recovery technologies (3rd-wave) will reduce and/or replace the use of steam based technologies.
- Gasification of coke/asphaltenes/coal can replace natural gas and provides integration across energy systems creating value for all the hydrocarbon assets
 - ❑ Clean power
 - ❑ Source of heat and hydrogen in the oil sands industry
 - ❑ Feedstock for fertilizer and methanol production
 - ❑ A future source of petrochemicals and ultra-clean fuels
 - ❑ Allows for capture and storage of CO₂, enabling enhanced oil and gas recovery to be expanded
- Alberta destined to develop world's largest gasification capacity

Summary

- Gasification is by far the cleanest coal/coke conversion technology
 - ❑ Inherently lower SO_x, NO_x, Hg and PM
 - ❑ Potential for lowest cost removal of CO₂
 - ❑ ~40% less water usage than PC
(2/3 of power generated in gas turbine; does not require cooling water)
- Power plants utilize significant quantities of water in generating electricity or hydrogen
- Water management options
 - ❑ Innovative water re-use and recovery
 - ❑ Reuse of power plant cooling water waste heat
 - ❑ integration with oil sands operations
 - ❑ Integration with conventional oil waterflooding
 - ❑ Other non-traditional sources of process and cooling water